Office of Environment, Safety and Health, EH-33 • U.S. Department of Energy • Washington, DC 20585

Operating Experience Summary

Office of Nuclear and Facility Safety

April 27 — May 12, 2000

Summary 2000-09

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EVENTS

1. TELEVISION TRUCK ANTENNA CONTACTS OVERHEAD POWER LINE INJURING THREE

On May 2, 2000 in Washington, DC, a television crew was injured when their transmission antenna contacted an overhead power line. The TV crew was extending the antenna mast from their truck to transmit a live broadcast, when the mast contacted an overhead power line and caused a small electrical fire and explosion inside their van. A camera operator outside the truck and an operator inside the truck were taken by helicopter to the Washington Hospital Center for treatment of burns. One was listed in fair condition and the other was in serious condition. A third person who was less seriously injured was taken by ambulance to another local hospital.

The TV crew was at the location to transmit a breaking story and was attempting to raise their transmitting antenna from their TV van to begin a live broadcast. The antenna struck the overhead power line and caused a ground fault in the electronics of the van's TV equipment. The incident occurred about 9:30 PM and the lighting above the van was poor, which contributed to obscuring the power lines.

EH engineers searched the ORPS database for recent events where the failure to use spotters and the lack of operator awareness of overhead obstructions caused equipment to contact overhead lines. Some examples follow.

- OE Summary 99-29 reported that on July 14, 1999, at the Weldon Spring site, a subcontractor operator apprentice driving a trackhoe failed to lower its boom, which then contacted and pulled down a communications cable and a 110-V signal line. The overhead lines, approximately 18 feet above ground level, were attached to a junction box on a pole, and one of the lines was pulled loose from its connections in the junction box. A ground anchor attached to a guy wire on the pole was pulled 2 ft out of the ground, and the messenger cable supporting the lines also broke where it was attached to the pole. The trackhoe operator notified his foreman and the job superintendent of the accident, and they notified contractor and DOE safety supervisors. Site personnel barricaded the area to prevent through traffic and to ensure the safety of personnel in the area. They determined that the communications cable was unnecessary, so it was abandoned. The 110-V signal line was reattached to its terminals, and the pole was straightened and reset into position. Additionally, a 14-inch orange warning ball was attached to the remaining signal line. (ORPS Report ORO--MK-WSSRAP-1999-0016)
- On April 19, 1999, a forklift operator at the Los Alamos National Laboratory contacted a hanging communications cable with the forklift's mast while maneuvering towards a load. Although the force of the impact snapped a support cable and broke a utility pole cross arm, the communications cable did not break. Investigators determined that the equipment move had been planned and walked down and that spotters were required. They also determined that the forklift operator, without spotters, used a larger forklift than required by the work plan. The communications cable was suspended at a height of 14 feet, and the mast on the larger forklift extends approximately 16 feet vertically with the forks still positioned near the ground. Following the event, the employees who performed the walk-down stated that they had failed to see the low-hanging communications cable. Corrective actions for this event included (1) placing signs on the instrument panels of all forklifts exceeding 10-ton capacity to alert the operators of the minimum and maximum heights of the mast and (2) requiring forklift operators to perform a walk-down and identify potential hazards before beginning work. (ORPS Report ALO-LA-LANL-CHEMLASER-1999-0003)
- On November 23, 1998, the boom of a trackhoe being driven by a subcontractor operator at a peripheral property of the Grand Junction Projects Office struck a 440-V overhead electric utility line. The power line was clearly visible, with no obstructions, and the work crew, including the trackhoe operator, had recently attended a safety briefing that specifically addressed the overhead power line and the procedure to be followed when moving equipment near it. The line was high enough to allow the trackhoe easy passage underneath provided the boom was lowered. Additionally, the supervisor of the trackhoe operator had discussed the overhead line with him and had instructed him to ensure the trackhoe boom was lowered while passing under the line. To prevent recurrence of this event, the work procedures were modified to include requiring a spotter when moving heavy equipment under power lines and locating power line warning signs at least 25 ft from them. (ORPS Report ALO--MCTC-GJPOTAR-1998-0013)

These events demonstrate the importance of exercising extreme caution when operating heavy machinery such as trackhoes, forklifts, fork trucks, and cranes in the vicinity of overhead obstructions. DOE facility managers should ensure that facility personnel and off-site vendors who operate equipment on site property are aware of any overhead hazards and that these hazards are clearly marked for clearance requirements and visibility. Work planners should inspect overhead hazards and clearances at job sites and over entire routes to be traveled by heavy equipment. Identified hazards should be described in work documents and thoroughly discussed in pre-job briefings. Equipment operators should walk down areas to identify and evaluate overhead hazards. Spotters should be required for all construction activity involving heavy equipment. They should be required for any movement of heavy equipment in the vicinity of obstructions and should have no other duties while heavy equipment is in use. Operators should be prohibited from operating or moving equipment unless a spotter is present.

OSHA regulation 29 CFR 1926.550(a)(15)(iv), "Cranes and Derricks," states that a person shall be designated to observe clearance of the equipment and give timely warning for all operations where it is difficult for the operator to maintain the desired clearance by visual means.

KEYWORDS: construction, equipment, industrial safety, job planning, overhead, pole, power line, safety hazard

FUNCTIONAL AREAS: Construction, Industrial Safety, Work Planning

2. ELECTRICAL TECHNICIAN PERFORMS WORK WITHOUT SAFETY TRAINING

On May 2, 2000, at Savannah River Site, a subcontract HVAC/electrical technician was working at the Transuranic Waste Visual Examination Facility near a potentially energized 480V circuit without attending a formal Electrical Safety training. The worker was qualified for low voltage electrical work related to HVAC, but required additional training, according to the Site's Electrical Safety procedures. The worker was connecting low voltage wiring in an area that had high-voltage circuits and was not using appropriate personal protective equipment. Facility management stopped work, when a Solid Waste Management Facility engineer discovered the technician's inadequate training status. The worker was not injured, but there was a potential for a severe electrical shock.
(ORPS Report SR--WSRC-SLDHZD-2000-0004)

Investigators learned that the Subcontract Technical Representative overseeing the worker did not fully understand the scope of the worker's assignment nor recognize the hazards to which the worker was exposed. Investigators discovered that a previous lockout/tagout on a 13.8KV breaker feeding the area facilities had been recently lifted and a 480V breaker being tested in on-off positions was temporarily in the open position. Investigators determined that due to the absence of a regular electrical lockout/tagout to isolate hazardous energy and the fact that the worker was not wearing any insulated personal protection equipment, he was exposed to potential personal injury or even a life-endangering situation. Investigators learned that the worker believed a formal lockout/tagout to be in effect because the area 480V circuit was in an open configuration. Facility workers had been briefed on the precautions required to avoid potential hazards of energized circuits, but the technician had missed the safety meeting. Investigators also determined that the Work Clearance Permit did not identify potential electrical hazards associated with the work.

EH engineers identified similar events involving Electrical Safety infractions.

- OE Summary 99-38 reported two occurrences at the Savannah River that underscore the benefit of performing safe-energy checks immediately before beginning work under safety lockouts. On September 14, 1999, at the F-Tank Facility, workers discovered 110-V ac proximity voltage during a pre-work safe-energy check on a distribution panel. Proximity voltage refers to any hazardous, unshielded voltage close enough to the work point (usually in the same enclosure) to present a hazard to workers. On September 13, 1999, at the Tritium Facility, workers preparing to modify a welding machine discovered 120-Vac inside a weld control station during a pre-work safe-energy check. In each case, shift-operating personnel had signed that a lockout was satisfactorily established, and workers performing a conscientious safe-energy check discovered hazardous energy and eliminated the potential for serious injury.
  (ORPS Reports SR--WSRC-FTANK-1999-0029 and SR--WSRC-TRIT-1999-0022)
- OE Weekly Summary 98-16 reported that a wireman at the Nevada Test Site was replacing a 110-V breaker inside an energized 480-V panel without lockout/tagout or personal protective equipment. Investigators determined that facility procedures for energized work required using insulated gloves and tools and following

the "two-man rule." They also determined that site procedures did not permit work on energized systems unless a facility manager or a qualified supervisor approved it. (ORPS Report NVOO--LANV-NTS3-1998-0001)

These occurrences highlight the importance of pre-job safety training/briefing, job hazard analysis, communication, lockout/tagout application and pre-job hazardous energy check to ensure personnel safety. Operations supervisors should communicate with workers in sufficient detail all likely safety hazards associated with any job, and safety procedures required for a safe performance. Workers need job-specific training to maintain personal safety. Installation of lockout/tagouts and pre-evolution zero energy checks are good practices that are instrumental in preventing job-related accidents.

The following documents provide safety guidance in safe performance of electrical operations.

- DOE-HDBK-1092-98, *Electrical Safety*, contains guidance and explanatory material in support of OSHA regulations and nationally recognized electrical-safety-related standards.
- DOE-STD-1030-96, *Guide to Good Practices for Lockouts and Tagouts*, emphasizes installation of a Lockout/Tagout and that the adequacy of protection should be verified by the individual(s) who will work during its currency.
- DOE-STD-1031-96, *Guide to Good Practices for Communications*, highlights the effectiveness of clear, concise and correct communications between supervisors and personnel in conducting safe operations.
- DOE-STD-1036-96, *Guide to Good Practices for Independent Verification*, provides the guidelines for independent checking the system status or configuration without any influence or pressure to ensure safety of operations.

KEYWORDS: compliance, construction, electrical maintenance, inspection, independent verification, communications

FUNCTIONAL AREAS: Electrical Safety, Industrial Safety

3. POWER LOSS DURING SWITCHING OPERATIONS INITIATES EVACUATION

On April 18, 2000 at Oak Ridge, a ventilation system failure required personnel evacuation from an operating building due to partial power loss resulting from switching activities during scheduled preventive maintenance. A part of the distribution system in a temporary parallel configuration shifted full load to a single phase, when the work crew opened a toggle of the power switch, but immediately closed the switch to prevent damage to the equipment connected to the system. The B-phase fuse of a specific power switch in the switching plan failed when the crew opened the A-phase, thereby putting the total load on a single phase. The dispatcher directed the personnel to open the remaining phase to eliminate the single-phase condition and to separate the parallel configuration. This action cut off power and degraded the Criticality Accident Alarm System /Emergency Notification System in a large area of the site, requiring multi-building personnel evacuation. A timely emergency response by the site management ensured personnel safety. (ORPS Report ORO--LMES-Y12SITE-2000-0022)

Investigators determined that the Plant Shift Superintendent ordered an evacuation using the public address system, when he received the alarm indication of the power loss in the area. The Power Operations personnel restored power to all the affected buildings by developing and following an approved recovery plan. Personnel could not resume work in the main operations building, because one of the air samples showed high air-borne contamination count requiring respiratory protection. On April 19, 2000, the air samples indicated acceptable quality and normal operations resumed in the facility except for one area, where a ventilation fan motor did not start.

Investigators verified that the electrical crew used an approved switching plan for the parallel power feed system and appropriate personnel protective equipment for working on circuits in the 480-13,800 volt range. The investigators discovered that repair crafts personnel identified two 40-ampere breakers as under-rated. These breakers tripped during the switching operations, transferring the load to a single phase with an 80-ampere breaker for the 3-phase power supply. Investigators also determined that this full load transfer to a single phase damaged the ventilation fan motor. The electrical crew replaced the three breakers each with 130-145 ampere rating and also replaced the damaged fan motor, restoring the power system to its full rated capacity and all safety systems to normal operation.

EH engineers identified the following similar events.

- OE Summery 98-33 reported that on August 9, 1998, at the Idaho National Engineering and Environmental Laboratory, the facility manager reported that the plant emergency communications system became inoperable when workers switched it to temporary battery back-up power and the batteries failed. Plant personnel determined that the entire emergency communication system was inoperable. The work plan to switch to new feed cables installed under an electrical and utility system upgrade project required electricians to interrupt the main power supply and supply the facility with alternate power from a commercial tie-in or from a generator. Investigators determined that electricians were unable to use back-up power to run the emergency communication system while performing maintenance, so they used the battery back-ups instead. When the batteries discharged, the system became inoperable. The loss of the emergency communication system resulted in the loss of alarms and voice paging capability and reduced the safety margin for personnel in the facility in the event of an emergency. (ORPS Report ID--LITC-LANDLORD-1998-0025)
- OE Summary 98-18 reported that on March 6, 1998, at the Fernald Environmental Management Project, electricians preparing for an electrical system outage manually tripped a 480-volt circuit breaker and heard an unusually loud noise inside the breaker cubicle. They opened the cubicle door and observed smoke and flash burns inside the breaker. The electricians stopped work, ensured a hazardous condition did not exist, and made the proper notifications. They removed the breaker from service, examined it, and observed carbon tracks in the automatic-trip solenoid area. The breaker was a General Electric dashpot type circuit breaker retrofitted with a Siemens electronic trip mechanism. Investigators determined that a design deficiency caused an electrical arc when metal tabs on the operating mechanism came into close proximity with grounded components before the breaker was fully open. There were no impacts on environment, safety, or health as a result of this occurrence. (ORPS Report OH-FN-FDF-FEMP-1998-0010)

Such events underscore the importance of adequate design and effective preventive maintenance in smooth and safe operations and avoidance of costly down time at DOE facilities. Line management should ensure that no design deficiencies are introduced by substituting under-rated replacement components during scheduled preventive maintenance of equipment. Maintenance supervisors must consult with design engineers for correct replacement parts, if a like-for-like exchange is not available. The following documents can provide appropriate guidance.

- DOE Order 4330.4B, *Maintenance Management Program* requires periodic maintenance of the Department's facilities for safe operations.
- DOE-HDBK-1092-98, *Electrical Safety* provides guidelines for ensuring safety in the use of electrical energy at DOE facilities.

KEYWORDS: under-rated component, design deficiency, emergency response

FUNCTIONAL AREAS: Electrical Safety, Preventive Maintenance

4. 300 WATT HALOGEN LAMP MELTS AND DISTORTS GLOVEBOX WINDOW

On April 19, 2000, at Rocky Flats, an unattended, energized 300-watt halogen lamp melted and deformed a lexan glovebox ceiling window. A worker detected a burning odor and notified a supervisor who investigated the area, de-energized the lamp, and contacted radiation operations when he discovered the damage. Configuration control personnel placed an administrative hold on the glovebox and a Radiological Control Technician covered the damaged glovebox ceiling with a plastic sheet and tape to prevent possible contamination spread. Facility management initiated a work package to replace the window and scheduled a fact-finding meeting. There were no injuries associated with this event. Halogen lamps are capable of generating high heat that can cause serious injury to personnel, severe damage to equipment, and fire. (ORPS Report RFO--KHLL-771OPS-2000-0019).

Investigators determined that a glovebox worker used the halogen lamp because of poor glovebox room lighting conditions and that he placed the lamp directly on the top of the lexan ceiling window with its protective bulb cover removed. They determined that the lamp was left in that position for approximately forty-five minutes, raising the window temperature to the melting point. Investigators determined that the combination of the heat from the lamp and the weight of a flashlight resting on the ceiling window caused the window to sag approximately twelve-inches

into the glovebox. They determined that there was no contamination spread, although the deformation did induce a series of quarter-inch holes in the window. Investigators determined that a similar unreported event involving the misuse of a halogen lamp occurred a few years ago at Rocky Flats. Investigators have not determined if corrective actions were recommended or implemented as a result of this earlier event.

KEYWORDS: halogen lamp, glovebox, lexan

FUNCTIONAL AREAS: Industrial Safety

5. CONCRETE ROOFING CHUNK FALLS NEAR WORKERS

On April 27, 2000, at Savannah River, a 25-pound chunk of concrete roofing fell approximately 30 feet while a roofing subcontractor installed anchors and eyebolts for a fall restraint. The concrete fell into one of the building's controlled areas and in the vicinity of other workers. Facility management stopped all roof work and contacted facility engineering. There were no injuries associated with this event. Failure to follow correct procedure when installing concrete anchors can lead to serious injury or death. (ORPS Report SR--WSRC-CSWE-2000-0010)

Investigators determined that the roofing supervisor noticed a loose eyebolt and corresponding anchor when he inspected the subcontractor's work. They determined that the supervisor unscrewed the eyebolt, removed the anchor, filled the hole with tar mastic, and drilled another hole six inches from the abandoned hole before leaving for lunch. Investigators determined that when the supervisor and worker returned to the work area an hour later, a concrete chunk had separated from the ceiling and fallen to the floor. They determined from construction drawings that the concrete roofing was 4 inches thick and that according to the anchor bolt vendor, concrete should be at least two times greater in thickness than the bolt length. Investigators determined that the 3.125-inch deep hole was too large for the 4-inch thick concrete slab and that when the worker drilled a total of five holes, he weakened the concrete and caused it to fail. They determined that the subcontractor was responsible for planning the job and accounting for facility and anchor type.

Corrective actions include the following.

- Facility management will make programmatic changes to ensure that technical and safety personnel review the subcontractor's safety plan before work is started
- The subcontractor is to reassess the fall protection process, have their engineers submit a written path forward, and resubmit their fall protection plan
- Technical and safety personnel shall re-inspect the five anchors and eyebolts already installed
- Safety engineers shall verify that a drill stop is built into the drill to prevent a hole from being drilled completely through a slab.

EH engineers identified the following event involving fallen concrete.

- Operating Experience Summary 95-13 reported that on March 22, 1995, personnel at the Idaho National Engineering Laboratory (INEL) Advanced Test Reactor (ATR) reported an event that involved a concrete plug dropping through a hole in a concrete floor and into the room below. This event is considered significant because all the barriers to preventing personnel injury and equipment damage were breached. There was no damage to facility equipment and no personnel were injured as a result of this event.
  (ORPS Report ID--LITC-ATR-1995-0011)

KEYWORDS: concrete, anchor, drill, fall protection

FUNCTIONAL AREAS: Industrial Safety

6. INADEQUATELY SIZED BREATHING AIR SUITS TEAR WHEN OVERSTRESSED

On April 19, 2000, at Rocky Flats, two decontamination and decommissioning workers' supplied air suits received pinhole-sized tears rendering them inadequate for personnel protection. The workers had just placed a piece of

equipment on a table during routine decontamination and decommissioning work when a radiological control technician noticed the small tears in the workers' suit backs, stopped the evolution, and removed the workers from the work tent. The workers did not experience air loss and they did not have detectable contamination as a result of the tears. The radiological control technician terminated the breathing air entry, and configuration control authority placed an administrative hold on all breathing air work until the suit quality question could be resolved. Facility management scheduled a meeting to determine the cause of the tears and to implement corrective actions. There were no injuries associated with this event. Failure of personnel protective equipment can cause personnel contamination or radiological uptakes. (ORPS RFO-KHLL-771OPS-2000-0021)

Investigators determined that the new suits had appeared to be smaller than usual over the previous month and that the problem suits all came from the same lot number. They determined that the suits were made of a heavier material and that personnel had to tug at them to put them on. Investigators determined that approximately 8-10 similar suit tears had occurred in the same location on the new suits and that they appeared to be torn from the inside out. They also determined that the suit fabric could have become bound against the suit's vortex cooler and could have lead to some of the tears. Investigators speculated that the new suits did not adhere to specific size criteria and as a result had been overstressed when personnel performed normal activities such as bending. They later discovered that the new suits were in fact within specified tolerances and that the older suits were larger and allowed for more freedom of movement. As a result of this investigation, facility management is considering revising breathing air suit specifications to better accommodate facility activities.

EH engineers identified the following event involving breathing air suits.

- Operating Experience Summary 99-44 reported that on October 19, 1999, at the Rocky Flats Environmental Technological Site, a worker performing decontamination and decommissioning activities in a contaminated room noticed a separation at an exhaust valve on his bubble suit when he exited the room and removed the suit. Radiological control technicians surveyed both the suit and the worker and found no contamination. A supervisor informed the quality assurance group about the defect in the suit.
  (ORPS Report RFO--KLL-771OPS-1999-0053)

KEYWORDS: breathing air suits, equipment defects, personnel protective equipment, contamination

FUNCTIONAL AREAS: quality assurance

7. STUCK OPEN X-RAY SHUTTER

On April 19, 2000, at Ames Laboratory, a researcher changing out a sample for irradiation reported to supervision that the X-ray machine refused to restart. Health physicists found the shutter covering the x-ray port jammed open. The researcher may have received a small radiation exposure to his fingers while working in the beam from the open shutter. Malfunctioning x-ray equipment can result in unexpected or unintended worker exposure.
(ORPS Report CH--AMES-AMES-2000-0002)

Investigators determined that the researcher was retrieving one sample that had been irradiated overnight and was placing a second sample for similar irradiation. The machine was powered down to 2mA/9kV before opening the shielding to retrieve the first sample. All indications were that the shutter was still closed when the researcher opened the shielding to insert the second sample. In an attempt to start the run using the control computer, the researcher saw electronic failure messages and warning lights. The researcher then telephoned the program safety coordinator who locked the machine out of service. The machine is now out of service.

Facility management is working with the x-ray machine's manufacturer to determine whether the warning lights were working properly, and when the shutter jammed open. The manufacturer must determine if the sensor indicating a stuck open shutter was preventing startup. Investigators verified that the shutter mechanism is definitely jammed open.

The researcher was wearing a ring dosimeter on each hand. They require a direct hit to register a dose. The dosimeters were analyzed, and one read zero while the other read 30 mrem. The 30mrem reading is not unusual since the dosimeters are read quarterly.

Investigators are proceeding cautiously by assuming that the x-ray shutter was stuck open before retrieval of the first sample and the researcher received a radiation dose of 30 mrem. They do not know if the shutter jammed open in the attempt to restart the x-ray machine. The researcher would not have received a dose if the shutter had jammed open after the second sample had been inserted.

EH Engineers have reported similar occurrences involving failed safety components in high-energy equipment.

- Operating Experience Summary 99-32 reported that on August 6, 1999, at the Brookhaven National Laboratory, laser safety assessors from the DOE Brookhaven Group discovered that an interlock for a laser controlled area containing a Class IV excimer (XeCl) laser failed during a laser safety assessment. The interlock, which is designed to shut off the operating laser when the door to the laser controlled area is opened, failed to remove power to the laser as anticipated. Investigators determined that the laser interlock failed as a result of an electrical problem. A properly designed interlock system should be fail-safe (fail in a zero energy state). Class IV excimer lasers, which operate in the ultraviolet region, pose hazards to both the eyes and skin. (ORPS Report CH-BH-BNL-BNL-1999-0017)
- Operating Experience Summary 99-19 reported that on April 22, 1999, at the Brookhaven National Laboratory, safety personnel found that a laser interlock for an experiment on one of the beam lines at the National Synchrotron Light Source had been taped closed, which allowed bypassing the intended interlock function. Two visiting researchers (trained and qualified in the use of the laser) had bypassed the interlock to determine if the laser was operating properly. While the interlock, which prevents personnel exposure to the laser beam, was bypassed, the researchers held a screen that was sensitive to the laser wavelength in the path of the laser beam and watched the screen fluoresce. The laser operating procedure clearly states that bypassing the interlock is forbidden. (ORPS Report CH-BH-BNL-NSLS-1999-0003)
- Operating Experience Summary 98-42 reported that on October 15, 1998, at the Nevada Test Site, Los Alamos National Laboratory personnel performing a series of integrated dry runs discovered that three interlocks on the experiment room door were taped in a bypassed condition. The preliminary inquiry concluded that the bypassing might have taken place the preceding evening, when Bechtel Nevada personnel were ensuring that two class IV lasers were correctly aligned for the integrated dry runs. The test group director has prohibited the operation of x-ray and laser equipment until the incident is fully evaluated. If such equipment is operating while an interlock is overridden, entry into the area will not shut the equipment down, and personal injury could occur. (ORPS Report NVOO--LANV-NTS3-1998-0004)

KEYWORDS: X-ray shutter, radiation dose, ring dosimeter

FUNCTIONAL AREAS: Health Physics, Worker Safety

8. CRANE INCIDENT NEAR MISS

On April 26, 2000, at Richland, a rigging worker struck a radiological control technician (RCT) in the head with the eye of the 1-inch cable choker he was placing on its storage rack. The RCT was stunned, but did not lose consciousness. An hour later the RCT reported to first aid, was examined, and returned to work without restriction. Careless handling of equipment can cause serious worker injury. (ORPS Report RL--BHI-IFSM-2000-0008)

Investigators determined that a rigging worker lifted a 1-inch wire choker from a crane hook to place it in the storage rack inside a processing canyon after completion of heavy equipment lifts and radiological surveys. The rigging worker grasped the choker about 2½ feet from the top. The top portion (including an eye) was not rigid. It relaxed, bent over of its own weight, and struck the RCT. The rigging worker had swung the wire choker around while unaware that the RCT was just behind him. The RCT was wearing personal protective equipment for these work assignments, a cloth hood and a full-face powered air purifying respirator, but no hard hat. The rigging worker checked and found no evidence of skin breakage, but did not immediately notify supervision of the injury. Another RCT checked the PPE hood of the injured RCT for indication of an open wound and did not find any. The RCT continued work for an additional 45 minutes to an hour and completed his tasks. The crew exited the canyon and then notified the safety representative. The RCT was sent to first aid for examination, found to have a large raised bump on his head, and released without restriction.

Contractor management conducted a lessons learned meeting and developed a few corrective actions:

- Potential use of hard hats during crane operations will be evaluated;
- Riggers will be required to establish a safety perimeter prior to conducting crane lifts in high radiation areas;
- Injuries sustained during work assignments must be reported immediately to supervision and receive prompt medical attention.

EH Engineers have reported similar occurrences involving a crane lift near miss in the following Summaries:

- Operating Experience Summary 99-32 reported that on August 4, 1999, at the Rocky Flats Environmental Technology Site, Solar Ponds Plume Project, a laborer's leg became entangled in a tag line attached to a load being moved by a crane operator. The laborer was acting as a spotter for the operator, and the line pulled him off balance before the crane operator noticed what happened. Because the crane operator could not see the spotter's lower body, he did not immediately notice the spotter's leg was entangled. However, he did notice the spotter looked distressed, so he stopped operations. The spotter untangled his leg from the tag line, regained his composure, completed the lift, and notified his foreman of the event. Although the spotter was not injured, the line lifted his leg approximately to his waist before the crane stopped. Failure to observe safe hoisting and rigging practices can lead to the loss of positive control of loads and can result in personnel injuries. (ORPS Report RFO--KHLL-ENVOPS-1999-0004)
- Operating Experience Summary 99-21 reported that on May 20, 1999, at the Argonne National Laboratory-East CP-5 Reactor, riggers were attempting to remove a 400-lb beam port casting from the face of a concrete monolith (biological shield) using the reactor building polar crane when a nylon lifting sling broke. The recoil caused the crane block to swing over, although it did not hit the reactor monolith. The riggers had believed the casting was loose from the monolith and attempted three times to remove it. The sling broke during the third attempt. Although the riggers and the crane operator thought that the casting was free from the monolith, they should have realized that it wasn't after the first attempted lift failed. There were no injuries as a result of this event but the failure of rigging under load is dangerous because of missile hazards or dropped loads. (ORPS Report CH-AA-ANLE-ANLEER-1999-0008)

Facility managers, maintenance, and quality assurance personnel should review the following references, which provide guidance and good practices applicable to the current issue (i.e., Quality Assurance, testing, surveillance).

- DOE-STD-1090-99, Hoisting and Rigging, provides guidance for hoisting and rigging and identifies related codes, standards, and regulations.
- American Society of Mechanical Engineers ASME Standard B-30.5-1994, applies to the construction, installation, operation, inspection, and maintenance of jacks; power-operated cranes, monorails, and crane runways; power-operated and manually-operated derricks and hoists; lifting devices, hooks, and slings; and cableways.

KEYWORDS: Choker, crane

FUNCTIONAL AREAS: Hoisting and Rigging, Worker Safety

9. TANK WATER LANCE HOISTING NEAR MISS

On April 21, 2000, at River Protection, a worker was nearly struck by a 40-foot section of carbon steel pipe that was being lifted over a nuclear waste storage tank. Two cranes were lifting the 60-foot long water lance to a vertical position when it parted at a coupling 20 feet from the top and swung wildly. There was no personal injury or property damage, with the exception of the need to re-thread the lance section. One worker holding the hose attached at the top of the lance escaped injury when the loose 40-foot pipe section swung back toward him. Poor job planning can result in property damage and worker injury. (ORPS Report RP--CHG-TANKFARM-2000-0033)

A water lance is used to flush a saltwell screen in a single shell waste before installation of equipment designed to remove liquid waste from the tank. Investigators learned that a field crew and riggers used a shop sketch to plan on-site fabrication of a new water lance. The lance consisted of three 20-foot sections of 1½ -inch diameter, Schedule 80, A-53 carbon steel pipe joined together by two taper thread couplings. The device was flushed with water to ensure removal of any foreign objects left inside the piping or assembly, but no efforts were made to remove all remaining flush water from inside the lance before setting up the lift. Approximately ten workers were required to

place the lance on sawhorses in preparation for crane and rigging personnel to lift the lance for installation into the Saltwell. The rigging supervisor approved a change of the originally planned single crane lift to a two-crane lift after crane and rigging personnel expressed concern about the unanticipated greater weight of the lance and its length. The lift was not considered a critical lift. Therefore, the specific lifting method was not included in the work procedure, and this change was not interpreted as a change in work scope.

Investigators determined that the water lance was lifted horizontally about 20 feet in the air, the crane holding the hose connection end (the top) elevated to move the lance toward the vertical, and the lance broke at the upper coupling. The two sections of the lance, still attached to the crane rigging, swung free with the end of the lower 40-foot section hitting the ground and bouncing at least twice (Figure 9-1.).

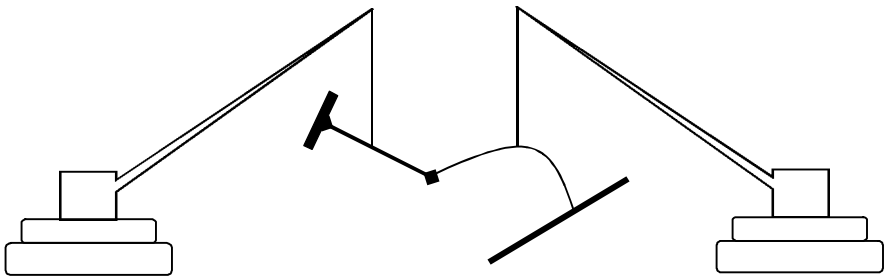

Figure 9-1.

Investigators learned that the couplings on the lance were only hand tight. This resulted in loose thread engagement, reducing the shear strength capacity of the threads. A field inspection of the failed threads indicated that the threads resisted a moment at the coupling joint. The pattern of failure at the threaded end of the pipe indicated that the crane supporting the hose end of the lance caused a bending moment at the first joint that may have exceeded the ultimate strength of the material. The lance severely deformed plastically at the first joint. Water inside the lance shifted by gravity to the nozzle end, adding a bending moment at the deformed joint, resulting in additional plastic deformation and the failure. The direct cause of the pipe/coupling connection failure, as determined by engineering analysis, was inadequate design of the lance that resulted in excessive stress applied to the threaded connections during the lift. Investigators determined that there was a lack of clearly defined procedures governing the fabrication and use of fabricated tools like the water lance. No engineering evaluation was performed to determine if the construction of the lance was suitable for its intended purpose and the stresses applied during deployment.

Investigators learned that the two-crane approach used to rig this lance was similar to other successful critical lifts to place a long horizontal component into a vertical position for installation into a tank, such as Saltwell screens and pumps. The engineering evaluation concluded that the forces applied to the connections as a result of the rigging were the cause of the failure. Previous lifts of lances have been with a single crane attached at the upper hose end in part to prevent the spread of any contaminated water in the lance. The fluid would drain out into the waste tank. The procedure did stipulate removal of all excess water in this newly fabricated water lance. Radiological concern was not a factor since the water was uncontaminated and clean. Coordination of the use of two cranes is normally challenging even during daylight hours and, this lift was performed under poor lighting conditions at 3:00 am. Investigators learned that the lift rate was faster than normal, which resulted in poor control of the flush hose at the top of the lance and the paying out of bonding wire during the lift. This may have contributed to excessive flexing of the pipe. The entire crew of riggers was also not briefed on the rigging supervisor’s field decision to change from one to two cranes.

Several corrective actions have been proposed to prevent a similar occurrence:

- New water lances will be constructed from an engineering design with sections welded together.
- Checks will be made of similar types of lifts to improve proficiency.
- Careful evaluation will be made of rigging configuration prior to a lift.
- More accurate estimates of weight of equipment will be made before a lift.
- Work packages will be changed to ensure that all water is drained from the lance before the lift.
- Exclusion lifting zones will be posted as a safe boundary for lifts.
- Work packages will ensure that the entire rigging crew is briefed on the use of a 3-point lift when indicated instead of the more usual 1-point lift.
- Work packages will mandate that adequate lighting be provided for lifts.

Facility managers, maintenance, and quality assurance personnel should review the following references, which provide guidance and good practices applicable to the current issue (i.e., Quality Assurance, testing, surveillance).

- DOE-STD-1090-99, *Hoisting and Rigging*, provides guidance for hoisting and rigging and identifies related codes, standards, and regulations.
- American Society of Mechanical Engineers Standard B-30.5-1994, applies to the construction, installation, operation, inspection, and maintenance of jacks; power-operated cranes, monorails, and crane runways; power-operated and manually-operated derricks and hoists; lifting devices, hooks, and slings; and cableways.

KEYWORDS: water lance, crane, saltwell screen, field pipe fabrication

FUNCTIONAL AREAS: Hoisting and Rigging, Maintenance, Industrial Safety

10. WEAKNESS IN PERSONNEL EVACUATION PROCESS

On April 17, 2000 at Sandia National Laboratory, facility operations personnel discovered a diagnostician in an area where high voltage tests were to be conducted involving a trigger generator. This worker had been inadvertently missed during the mezzanine evacuation prior to two actual tests. No one was injured as a result of this incident. Incomplete evacuation of a facility may lead to serious worker injury in the most adverse circumstances.
(ORPS Report No. ALO-KO-SNL-1000-0006)

Investigators determined that 15 minutes prior to high voltage testing an evacuation announcement had been made over the public address system. Verbal announcements were also made during the evacuation and a final public address announcement was made declaring the areas evacuated and ready for testing. The testing required high voltage system charging, which activated the highbay siren and red beacons. Two operations personnel swept the mezzanine area, making visual checks and verbal announcements of an evacuation in progress. Doors were closed and interlocks engaged after the sweep was completed. The diagnostician missed by the sweep did not respond to the verbal shouts, the public address announcements, the high voltage siren, or the high voltage flashing lights.

The facility was in post maintenance testing configuration. Investigators learned that fluid levels in both the water and oil section were below what is required for a full energy down line experiment. Only two or three feet of oil is required for the type of high voltage testing in progress. The fluid level is a visual indication of the status of the facility. The diagnostician who remained on the mezzanine during the high voltage testing was familiar with the particular work, but as a relatively new unescorted worker, was unfamiliar with all the different evacuation procedures. The mezzanine is a busy, noisy work area and the public address system is often garbled and not easily understood. The diagnostician was in a position and area that evacuators could easily miss during an evacuation. Evacuation procedures call for several different types of evacuations involving different types of audible (siren) and visual (flashing lights) signals depending on the particular area and purpose of the evacuation. The diagnostician did not understand the evacuation signals and their importance to this evacuation.

Investigators also learned that facility training on evacuations and the meaning of various flashing lights and sirens is limited to operations personnel. Many support personnel (diagnosticians, etc.) are granted unescorted access to the building via a badging process. However, this process does not include an explanation of the visual and audible warnings that exist in the building. Training for sweep personnel includes procedural walkthroughs and verbal testing. Evacuation training is done to the procedure. Qualification involves reading and testing on the procedure and performance of a formal walk through.

Facility management intends to hold a root cause analysis meeting at which two particular subjects will be discussed:

- Current training is organization-based, not facility based. Experimenters, as opposed to operations personnel, are often untrained, recent hires. Comprehensive facility-based training appears more appropriate to educate unescorted experimenters as well as operations personnel on all relevant health and safety aspects of working around this facility.
- The Z facility has undergone a number of configuration changes in the past 2 years. Evacuation procedures have not been properly updated to reflect configuration management of the facility. Several blind spots have been created over the last 2 years by the incorporation of additional testing equipment, making an adequate evacuation sweep much more difficult. Evacuation procedures will be rewritten to reflect the latest equipment configuration.

EH Engineers have reported similar occurrences involving weaknesses in the evacuation process in the following Summaries:

- Operating Experience Summary 98-23 reported that on June 6, 1998, at the Brookhaven National Laboratory Alternating Gradient Synchrotron, the operations coordinator placed the synchrotron ring in the beam-enabled state while a technician was still inside the ring. The gate watch mistakenly believed that the technician had signed out when he told the operations coordinator that all personnel were out of the ring, and the operations coordinator decided to forego a three-man sweep of the accelerator. The three-man sweep is required before placing the ring in the beam-enabled state. The synchrotron is a proton accelerator, and the ring is a high-radiation area when the proton beam is present. (ORPS Report CH-BH-BNL-AGS-1998-0003)
- Operation Experience Summary 96-48 reported that a security technician at the Lawrence Livermore National Laboratory was hit in the eyes by the reflected beam from an operating class IIIB laser when he entered a room. Investigators determined that a lead experimenter had left the laser on overnight without meeting Laboratory safety requirements. Investigators found the laser power cutoff was not interlocked to the door, there was no alarm, and warning signs were not posted outside the door in violation of access control requirements for the room. (ORPS Report SAN--LLNL-LLNL-1996-0060)

This event underscores the need for effective access control to areas where hazardous conditions exist and demonstrates the importance of a strong radiological control program for all radiation areas.

KEYWORDS: access control, lockout and tagout, radiation protection

FUNCTIONAL AREAS: Radiation Protection, Worker Safety

11. LOCKOUT / TAGOUT PROBLEMS CONTINUE

During this review cycle nine lockout/tagout occurrences were reviewed. Five of these involved electrical systems and four concerned piping and valving. Of these nine, three were near misses.

- On April 18, 2000, at the Weldon Spring site, two subcontractor employees disconnected a hose and capped the open end while the other end was connected to a pump on automatic start. The pump activated, pressurizing the hose. Two other contractors tried to re-connect the hose and when they uncapped the hose the pressurized, contaminated water sprayed a supervisor who was standing nearby and was not wearing any PPE. The supervisor's clothing was monitored and found contaminated by radon plate-out. Failure to lock out and tag out potential energy sources can injure employees and cause equipment damage. (ORPS Report ORO--MK-WSSRAP-2000-0007
- On May 5, 2000, at Idaho, a lockout/tagout was applied correctly to a pump scheduled for work, however the construction crew disconnected the wiring to another pump which did not have a lockout or tagout in place. There were no barriers in place for several hours to protect personnel from the disconnected 240-volt lines. Failure to protect personnel from potential electrical hazards can cause serious injury or death. (ORPS Report ID--BBWI-LANDLORD-2000-0015)
- On May 8, 2000, at Savannah River, an inadequate lockout was discovered when personnel discovered a three-way valve was wrongly positioned during installation of a lockout. No one was injured. (ORPS Report SR--WSRC-WVIT-2000-0010
- On May 3, 2000 at Savannah River, a lockout was removed from an Uninterruptable Power Supply when a manager believed that the work was finished and the lockout could be removed. The lockout holder had not signed for the release of the lockout. Electrical work in that area was stopped when the situation was discovered. No one was injured as result of this error. (ORPS Report SR--WSRC-TRIT-2000-0005
- On April 28, 2000 at Oakland, a laboratory electrician locked out what he believed was the proper breaker. When he began to remove it, a disconnected line conductor came in contact with the panel enclosure. A ground fault cascaded and tripped an upstream breaker. Work on the Cyclotron in the building was disrupted. No one was injured. (ORPS Report OAK--LBL-OPERATIONS-2000-0002)
- On April 29, 2000 at Savannah River, a work plan review for instrument air system work already in progress found that the work was not completely covered by a lockout/tagout order. Maintenance activities were stopped and the system was returned to a safe configuration. No personnel injuries occurred and no equipment was damaged. (ORPS Report SR--WSRC-LTA-2000-0012)
- On April 26, 2000, at Richland, an authorized worker electrical lockout was removed prior to returning the equipment to an operational configuration. A craftsman removed his authorized lockout when his portion of the task was complete and left the locking device in place for the next craft to install his lockout. The system could have been energized before the next lockout was applied. (ORPS Report RL--PHMC-FSS-2000-0005)
- On April 18, 2000 at Savannah River, an improper lockout was discovered on a three-was valve. A valve handle for a three-way selector valve used as an isolation point was improperly installed. As a result the valve was not isolated from service. (ORPS Report SR--WSRC-WVIT-2000-0009
- On April 10, 2000 at Nevada, a lockout/tagout procedure was violated while cutting potential transformer circuits off a terminal block. An electrician's pliers touched a 110-v phase wire and blew a fuse. The crew did not establish a lockout/tagout or follow hot work procedures. There were no personnel injuries. (ORPS Report NVOO--BNLV-NTS-2000-0008)

These occurrences underscore the importance of applying disciplined conduct of operations while complying with lockout/tagout (LO/TO) program requirements. A good LO/TO program is an important element of an effective conduct of operations program. DOE LO/TO programs serve two functions. The first, defined in 29 CFR 1910, *Occupational Safety and Health Standards*, and DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, is to protect personnel from injury and protect equipment from damage. The second function is to provide overall control of equipment and system status. The standard states that an effective LO/TO program requires three elements: (1) all affected personnel must understand the program, (2) the program must be applied uniformly in every job, and (3) the program must be respected by every worker and supervisor.

The LO/TO program is the primary barrier to employee injury or death. However, it is an administrative program that cannot work properly unless all individuals understand their responsibilities and carry them out with a high degree of discipline. Facility managers should ensure that all managers and supervisors understand their expectations for the LO/TO program and that they effectively communicate and enforce them with all facility personnel. These expectations should include attention to detail, verbatim compliance, effective communications, and defense in depth.

Facility managers should also review DOE/EH-0540, Safety Notice 96-05, *Lockout/Tagout Programs*. The Notice states that workers must be cognizant of lockout/tagout boundaries and that they must verify that no hazardous energy exists within these boundaries. It also summarizes lockout/tagout events at DOE facilities, provides lessons learned and recommended practices, and identifies lockout/tagout program requirements. Safety Notices are available at http://tis.eh.doe.gov/web/oeaf/lessons_learned/ons/ons.html.

The *Hazard and Barrier Analysis Guide*, developed by OEAF, includes a hazard-barrier matrix that demonstrates that lockouts/tagouts provide the most effective barrier against injury. When implemented properly, a lockout/tagout provides a high probability (greater than 99 percent) of success for risk reduction. A copy of the guide is available at http://tis.eh.doe.gov/web/oeaf/tool/hazbar.pdf.

KEYWORDS: conduct of operations, personnel error, procedures, subcontractor

FUNCTIONAL AREAS: Procedures, Industrial Safety, Hazards Analysis, Work control, Licensing/Compliance